Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2017

SUBJECT: HYPERSONIC AEROTHERMODYNAMICS (AAE 4003)

REVISED CREDIT SYSTEM

(30/12/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** questions.
- Missing data may be suitable assumed.

1A. Derive and explain basic hypersonic shock and expansion waves **(05)**

1B. What is the importance of Ballistic and Lifting coefficients in Hypersonic flows? Explain it with their derivations and Velocity – Altitude Map. **(05)**

2A. What is Hypersonic Equivalence principle? How it's related to solve problems in Blast wave theory for blunt nose cylinder and blunt noses slab? (Draw the diagrams). Write down their final results of pressure distribution and shock wave shape in terms of 'x'. **(05)**

2B. Draw the schematic diagram of Hypersonic Shock Wave Boundary layer interactions and explain their features **(05)**

3A. Derive and explain the centrifugal force correction to Newtonian theory (Newtonian – Busemann theory) **(05)**

3B. What is meant by hypersonic transition and explain in details about the parameters which influencing the hypersonic transition. **(05)**

4A. What are the use of non-dimensional parameter in inviscid hypersonic? Prove with an example that in high speed hypersonic, the properties become independent of Mach number. **(05)**

4B.. Consider the flat plate at an angle of attack 11degrees in a Mach 8 inviscid flow. Calculate the pressure coefficients on the top and bottom surface of the plate, the lift and drag coefficients and the lift-to-drag ratio by using **(05)**

a) Exact shock – wave and expansion wave theory
b) Newtonian theory
c) Compare the both results

5A. Consider a flat plate at zero angle of attack in airflow at 15km altitude with chord length 1.8m and reference area $55m^2$(assume area per unit span). If then calculate the followings **(05)**

Case A- Insulated plate	Case B- Hot wall	
1) Local shear stress at 1.2m from leading edge ($C_f \sqrt{Re.x} = 0.42$) 2) Total drag of the plate	1) Local shear stress at 1.2m from L.E ($C_f \sqrt{Re.x} = 0.53$) 2) Total drag of the plate 3) Heat transfer rate at 1.2m from leading edge(T_W=576K) and $C_H \sqrt{Re.x} = 0.31$	P_∞=10kPa,T_∞=216.6K,T_e= T_∞, $\mu_\infty=1.42*10^{-5}$kg/m.s, V_∞=3200m/s, Pr=0.725, R=287, γ=1.4

5B. What is self-similar solutions and write down its advantages & procedures. **(05)**